

# **Wood-Burning in Davis: Recommended Ordinance**

A Recommendation to the Davis City Council from the  
Davis Natural Resources Commission

July 26, 2010

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## **1. Recommendation to Approve the Draft Ordinance**

The NRC recommends that the City Council approve the proposed attached ordinance as presented and instruct Staff to implement the technical and legal aspects of the program. We also recommend that Staff be instructed to expeditiously prepare and implement an outreach program including utility bill inserts and notification of local media to inform the public of the ordinance and instruct them on proper fire-starting and fire-burning methods.

## **2. Introduction and Background of the Proposed Ordinance**

The NRC recognizes that while many Davis residences find fireplaces and wood burning appliances a desirable amenity, wood smoke consists of fine particles, which are regarded as a health hazard by both national and state health professionals. Air Quality Standards have been created identifying maximum tolerable levels of particulates in the air. Unfortunately, use of wood burning appliances under certain local conditions can result in wood smoke concentrations that significantly exceed particulate air quality standards and adversely affect nearby residents. The operation of wood burning appliances therefore needs to be regulated so as not to cause significant health risks to residents who live near them. The NRC also recognizes that it is impracticable for a member of the public to demonstrate by measurements that intermittent operation of a wood-burning appliance has resulted in particulate concentrations that exceed air quality standards or create a health hazard. It is also impracticable for most individuals to simulate their local conditions in a computer model to determine whether operation of a wood-burning appliance will create or has created a health hazard.

Currently, residents affected by wood smoke have no feasible recourse to limit or stop their exposure and potential health impacts. Thus it is necessary to define conditions under which residents are likely to be unwillingly exposed to wood smoke and may suffer health impacts. Accordingly, the NRC recommends this ordinance to the Davis City Council as a means of defining the meteorological and operational circumstances under which use of different types of wood-burning appliances are likely to create a health hazard, and to prohibit operation of such devices under such circumstances,

The issue of wood burning restrictions has been deliberated at numerous City Council meetings and over a dozen NRC meeting over the past 3 years. During this time this issue has also been prominently discussed and displayed in the local media. The Davis Enterprise has published numerous feature and stand-alone articles and literally dozens of Op-Eds and Letters to the Editors from both opponents and supporters of wood-burning restrictions. The opinions of the letters spanned the complete range of options from opposition to any form of wood-burning restrictions at all to support for immediate and total bans on all forms of wood burning and were about evenly matched between opponents and proponents of the proposed ordinance. The issue of wood burning has also been the subject of numerous articles and threads on the Davis Vanguard Blog, a radio interview on DCTV, 2 articles in the UC Davis Aggie, television coverage on

Channel 10 News, and an informational article in the Yolano Flame newsletter of the local Sierra Club.

In November of 2008, the Davis City Council choose not to impose any restrictions on wood burning but instead elected to accept Dr. Cahill's offer to monitor PM2.5 concentrations at City Hall during the winter. (PM2.5 means particulate matter less than 2.5 micrometers in diameter.) Dr. Cahill's subsequent report (pertinent findings are presented below) was analyzed by the NRC which again recommended a series of mandatory restrictions to the Davis City Council. Last January, the City Council again elected to not impose any mandatory restrictions on wood burning but instead passed a resolution supporting the existing Yolo-Solano Air Quality Management District voluntary wood burning restrictions and supporting continued studies on neighborhood air quality and collecting citizen complaints.

Since then, a 2<sup>nd</sup> monitoring program has been completed by the YSAQMD and the results have been presented to Council and the NRC. Additionally, citizen complaints were collected and analyzed and the results discussed by the NRC (pertinent findings are presented below).

The NRC formed a new sub-committee on wood burning in May of 2010 after receiving the reports of the YSAQMD and Dr. Cahill and hearing analysis of their findings presented by Yolo Clean Air. The sub-committee considered the new reports as well as other technical and medical information previously submitted to the NRC, and considered a broad range of alternatives. The subcommittee prepared an initial recommendation to the NRC for its consideration as an intermediate product to this recommendation to the City Council. The full commission reviewed and approved this final recommendation at its meeting in July , 2010, which is now presented as this recommendation to the City Council.

### **3. Current Wood Burning Restrictions in Other Northern California Jurisdictions**

Currently, mandatory restrictions against wood burning under certain conditions have been promulgated by the San Joaquin Air Pollution Control Board (covering the San Joaquin Valley from Bakersfield through Stockton), the Bay Area Air Quality Management District (covering the greater nine-county San Francisco Bay area), and the Sacramento Air Quality Management District (covering Sacramento Co). This results in mandatory cessation of wood burning in those jurisdictions any where from 10 to 50 days of the 120-day wood burning season. It is estimated that from 90-95% of the entire population between Bakersfield and Sacramento including the entire Bay area are subject to some type of mandatory wood burning restrictions.

These mandatory wood burning restrictions imposed by the major Air Quality Management Districts were implemented for the sole purpose of achieving compliance with EPA regional air quality standards. That is, when regional PM2.5 air quality was projected to be in excess of federal air quality standards, wood-burning restrictions were imposed for the following day in an attempt to lower the actual PM2.5 during the next

day in question. Violators are initially warned and then subjected to increasing fines and/or imprisonment for repeated violations. Each of these Air Quality Management Districts has also imposed additional wood burning restrictions pertaining to the maximum opacity of smoke from wood burning appliances. For instance, both the Sacramento and the Bay Area Air Quality Management Districts prohibits any wood burning that produces any visible smoke beyond an initial start-up period. Each of these Districts also prohibits the sale of firewood as seasoned with moisture content in excess of 20%.

Additionally, each of these Air Quality Management Districts have also promulgated a "Model Wood Burning Ordinance" designed to assist local jurisdictions in imposing additional restrictions over and above those imposed by the regional Air Quality Boards. Almost all of these Model Ordinances are identical and one provision common to all mandates the phase-out of all wood-burning in all non EPA Phase II-Approved wood burning appliances beyond a specified time period. Portions of the Model Wood Burning Ordinance have been adopted by many different municipalities and counties within these jurisdictions. For instance, 41 cities and/or counties in the Bay Area Air Quality Management District have implemented some portion of the Bay Area Air Quality Management District's Model Wood Burning Ordinance. Examples are the County of Marin and a number of municipalities in that County which now ban operation of all non-EPA-Phase II-Approved fireplaces and wood burning appliances in their jurisdictions

The City of Berkeley has gone well beyond these conventional types of restrictions. They recently has passed an ordinance in which a resident has a presumptive exposure to a '*Smoke Health Hazard*' caused by an immediate neighbor whose property "*abuts or confronts a property with a wood burning appliance or a building that has a direct line of sight from the highest residential floor to the source of the smoke, and who resides within 120 feet of a source of wood smoke*". Such a resident may press a claim in Superior Court against such an immediate neighbor if the residents cannot otherwise amicably resolve any wood burning dispute through discussions or mediation. The basis for the determination of the 120 ft distance was through the use of computer modeling of wood smoke dispersion from chimneys using an EPA-approved atmospheric dispersion modeling tool called Screen3. This is the same modeling tool upon which the NRC's recommendations were based as presented in Appendix II. The NRC has determined, however, that the Berkeley wood smoke ordinance puts the onus of enforcement of wood smoke exposure on the complaining resident which is felt to be unfair and detrimental to the health and welfare of the citizens of Davis.

#### **4. Results of Past PM2.5 Monitoring and Wood Smoke Studies in Davis**

**Winter 2008-2009** – Downtown Davis PM2.5 air quality as measured by Dr. Tom Cahill outside City Hall was approximately 50% greater than that measured by the more rurally located CARB permanent monitor located west of Hwy 113. The PM2.5 concentrations in downtown Davis were slightly greater than those measured at the CARB downtown Sacramento headquarters indicating for the first time that air quality in downtown Davis was more polluted with respect to PM2.5 than downtown Sacramento

**Winter 2009 – 2010** - PM2.5 concentrations at a California Air Resources Board temporary monitoring site in East Davis measured approximately 80-100% greater than concentrations measured west of Hwy 113 by the CARB permanent monitor and in Central Davis by the YSAQMD temporary monitor, supporting the science that wood smoke effects can be very localized. As the East Davis monitoring site was not adjacent to any houses, it most likely under-represents the pollution burden borne by nearest neighbors of wood burners. Still, there were 19 days at the East Davis site in which federal air quality standards were exceeded for PM2.5 and deemed to be “Unhealthy for Sensitive Groups”. This number of days far exceeded (by 50%) the number of poor air quality days recorded at the Del Paso-Sacramento CARB permanent monitor which historically has been considered to have the worst winter PM2.5 air quality in the entire Sacramento Air Quality Management District’s jurisdiction. There were only 2 recorded days in which air quality was similarly deemed to be “Unhealthy for Sensitive Groups” at the other temporary and permanent Davis air quality monitors. Further the total number of complaints recorded by Davis residents was from 6 to 10 times greater per capita than those recorded in the Sacramento AQMD’s jurisdiction. And the number of individual complainants per capita was minimally from 2 to 2 ½ times greater than the per capita number of complainants in the Sacramento AQMD.

## **5. Development and Discussion of the Current Proposed Ordinance**

In response to presentation to the NRC of the above referenced 2009-2010 air quality studies in Davis, the NRC formed a new subcommittee in May, 2010 to draft a recommended ordinance and present it to the NRC for their consideration and approval for submission to the Davis City Council. The subcommittee used a sample contract previously developed by City Staff as an initial template and revised it according to the Subcommittee’s recommendations. This draft ordinance was considered by the full NRC at their June, 2010 meeting along with a draft of this report. The draft ordinance that resulted from these efforts and consideration by the full NRC is attached as Appendix A.

Policy Criteria - The NRC believes the draft ordinance meets the following policy criteria:

- 1) Simple – The ordinance must be short, simple, and easily understood by the average citizen.
- 2) Effective Protection for Susceptible Citizens from Neighborhood Wood Smoke “Hotspots” – The ordinance must address the problem of wood smoke accumulation at ground level in neighborhoods and the effects this has on nearby neighbors respiratory problems. The NRC has determined that the ordinance specifically must go beyond past efforts to just protect the general population by trying to limit excessive regional levels of wood smoke.
- 3) Science-based – The restrictions must be based on a defensible scientific analysis of the dispersion of wood smoke and the resultant potential exposures to Davis citizens.

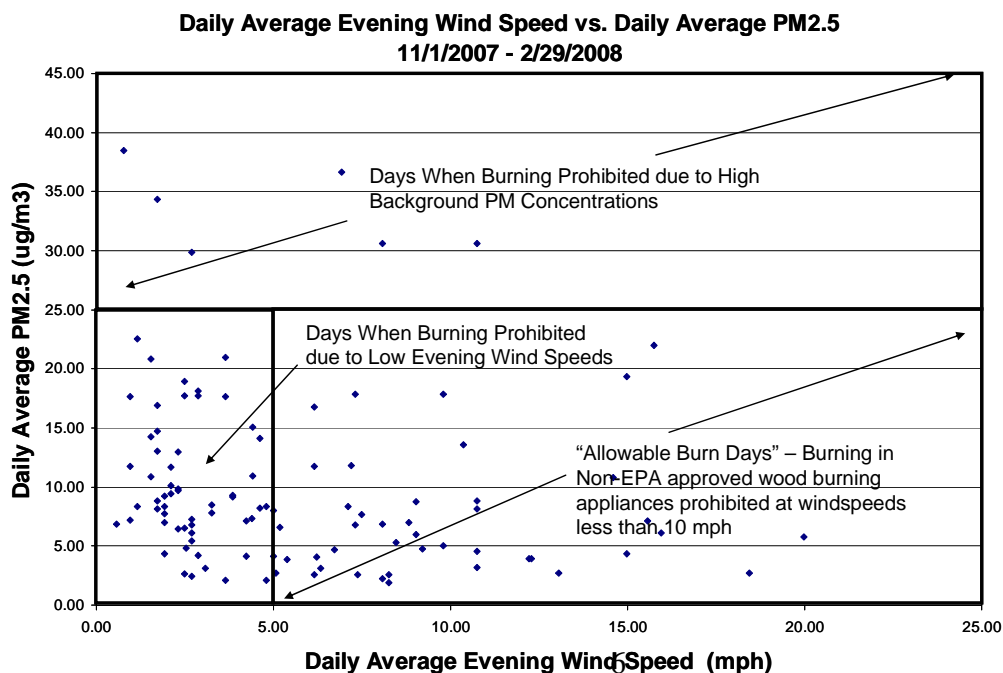
- 4) Easily Enforced – To the extent possible, the ordinance must be as easily enforceable as possible requiring a minimum of police effort to investigate and determine possible violations.
- 5) Minimum Staff Time – To the extent possible, the ordinance must be easy to administrate and require a minimum of city staff time to implement and maintain.
- 6) Balanced and Fair – To the extent possible, the ordinance must balance the rights of citizens to clean air while recognizing that some people have made substantial investments in improved EPA Phase II-Certified stoves and inserts and other highly efficient pellet-fueled wood burning appliances.

As in the previous ordinance proposed to the Council by the NRC, this proposed ordinance uses both wind-based and regional PM2.5-based trigger criteria to determine when different types of wood burning appliances can be used.

Previous Recommendation Sent by the NRC to the City Council - The NRC had most recently approved a recommendation to City Council that

- a) Restricted all wood burning on days which had either a projected high background PM2.5 air concentration ( $> 25 \text{ ug/m}^3$ ) or a projected low wind speed ( $< 5 \text{ mph}$ ).
- b) Allowed use of EPA Phase II-Approved wood burning devices on days in which the projected PM concentration was less than  $25 \text{ ug/m}^3$  and the projected next evening average wind speed was greater than 5 mph
- c) Allowed use of non-approved wood burning appliances only on days in which the projected PM concentration was less than  $25 \text{ ug/m}^3$  and the projected next evening average wind speed was greater than 10 mph. However, non-approved appliances would be phased out.

These recommendations were visually explained in the following graph that was included in the NRC's prior recommendations to the Council in late 2008.



Concerns Expressed by the Public about the Prior Recommendation - A number of concerns was expressed by both proponents and opponents of the previously proposed recommendation by the NRC to the Council.

1) It was stated that there was no quantitative allowance for use of wood burning devices with efficiencies much greater than EPA Phase II-Approved wood burning appliance (e.g. pellet stoves and high efficiency wood stoves). These units generally are designed to operate with maximum emissions of 2 g of PM<sub>2.5</sub> per hour compared to a maximum of 7.5 grams of PM<sub>2.5</sub> emitted per hour allowed by EPA Phase II-Approved stoves.

2) It was stated that the 6-hour proposed maximum burn time per day, while technically defensible in terms of public health, was unenforceable or too cumbersome or problematic to efficiently enforce.

3) It was stated that if Non-EPA Phase II-Approved wood burning devices (such as open hearths) could be safely operated under certain conditions then that operation should be allowed to continue in the future under those restrictions and therefore their allowable use should NOT be eventually phased-out.

4) It was stated that even if fireplaces were operated during allowable burn times, that improper operation of the wood burning device, as represented by the presence of visible smoke, could result in excessive emissions not anticipated under the previously proposed recommendations to the detriment of public health and safety of nearby neighbors and neighborhoods.

Current Recommendation of the NRC and Changes from the Prior Recommendation - The NRC believes there is merit in those arguments and addresses these stated concerns in their new recommendation to the Council.

As in the previous ordinance proposed to the Council by the NRC, the current recommendation uses both wind-based and regional PM<sub>2.5</sub>-based trigger criteria to determine when different types of wood burning appliances can be used. The proposed ordinance is thus different than that previously proposed to the Council by the NRC in those 4 areas.

1) A 3rd Allowable burn criteria designation for High Efficiency Wood Burning Appliances is now proposed – The previous proposal only allowed wood burning once next-day PM<sub>2.5</sub> concentrations were projected to be less than 25 ug/m<sup>3</sup> AND projected minimum wind speeds reached 5 mph. This current recommendation proposes that wood burning appliance with efficiencies substantially greater than EPA Phase II-Approved wood burning appliances (i.e. appliances with PM emissions less than or equal to 2.0 g/hr) be allowed only if next-day PM<sub>2.5</sub> concentrations were projected to be less than 25 ug/m<sup>3</sup> regardless of projected wind speeds. This was suggested by as a reasonable course of action in recognition of the comparably low PM emissions of these

appliances and is consistent with the wood dispersion modeling methodology employed in setting minimum wind speeds for less efficient wood burning appliances. We note that the Sacramento AQMD also currently has a 3-tier wood burning ordinance based on forecasted regional PM2.5 concentrations.

2) No 6-hour burn limitation per day is now proposed – The previous proposed wood burning ordinance submitted by the NRC recommended that there be a six-hour limitation on wood-burning on any one “Allowable Burn Day”. This was to prevent excessive build-up of wood smoke over the course of a day if someone was burning 24/7 that could otherwise result in total exposure by a nearby neighbor to the wood burner that would be in excess of federal standards. While the wood smoke subcommittee still believes this criteria is recommended for public safety concerns and to protect neighbors from potential constant exposure to wood smoke, the current proposal eliminates the 6-hour burn limitation requirement because of the expressed concern of enforcement difficulty.

3) No eventual phase-out of Non-EPA Approved appliances is now proposed – Previously, the NRC proposed that use of open hearth fireplaces and non-EPA Phase II – Approved appliances be phased out after two years. This was consistent with the Sacramento, the Bay Area, and the Yolo-Solano AQMD Model Wood Smoke ordinance which all similarly proposed such eventual phase-outs. The current subcommittee proposal does not recommend such a phase-out but instead recognizes that substantial protections are afforded by the minimum wind speed criteria proposed for use of non EPA Phase II-Approved wood burning appliances.

4. All wood burning must be done with no visible wood smoke emissions beyond an initial start-up period. - This is consistent with the regulations of the Bay Area and Sacramento Air Quality Management Districts that have existing mandatory restrictions which similarly prohibit visible wood smoke emissions as a proxy to ensure clean burning methods are employed by the wood burner. These restrictive burning regulations are in place and enforceable regardless of the type of wood burning appliance used or the meteorological conditions during which such wood burning appliances are used.

5. City staff is now given the option of setting fines at a lower level of their choosing between 10 and 100% of the limits the State imposes on municipalities. Previously, fines were specified at inflexible predetermined levels. The current fine limits may change over time, but currently they are: \$100 for first offense, \$200 for a second offense, and \$500 for each additional offense. Thus a first offender might pay as little as \$10 or as much as \$100, depending on the percentage level Staff chooses. The Council may prefer to set the level themselves, rather than delegating it to Staff, in which case the few relevant lines of the ordinance should be amended. Fines should be high enough to dissuade illegal burning and cover enforcement costs but should not bankrupt citizens. For this latter reason, the ordinance gives "the Courts" the option of reducing fines for hardship cases.



The main elements of this newly recommended draft ordinance are now as follows:

1. General

- Effective November 1, 2010, wood-burning will only be allowed on “Allowable Burn Days”, only using seasoned wood with a moisture content less than 20% by weight or pellets or manufactured wood products specifically manufactured for use in wood burning or pellet stoves, and only if wood burning produces no visible wood smoke emissions beyond an initial 0.5 hour start-up period .
- Each Allowable Burn Day will extend for a 24 hour period from midnight to midnight the next day. The determination of an “Allowable Burn Day” will, *in part*, be based on a forecasted average daily regional PM2.5 concentration of 25 ug/m3 or less as made by the Yolo Solano Air Quality Management District using its existing methodology.
- The type of wood burning appliance allowed for use on any Allowable Burn Day will be based on a forecasted average hourly wind speed for the intervening period of 6 PM to midnight on the day in question as made by the National Weather Service. This will allow “one-day before” announcement of “Allowable Burn Days” to provide timely notification of media and other means of information dissemination and allow citizens to plan one day ahead with respect to planned wood-burning activities.
- Stage III Allowable Burn Days - Only Use of High Efficiency Wood Burning Appliances Allowed (i.e. those with hourly PM2.5 emissions of less than 2.0 g/hour) - The forecasted average wind speed for the 6 PM to midnight period the following day is less than or equal to 5 mph AND the forecasted average daily regional PM2.5 concentration for the next day is 25 ug/m3 or less
- Stage II Allowable Burn Days - Only Use of EPA Phase II-Approved and High Efficiency Wood Burning Appliances Allowed - The forecasted average wind speed for the 6 PM to midnight period the following day is greater than 5 mph and less than or equal to 10 mph AND the forecasted average daily regional PM2.5 concentration the next day is 25 ug/m3 or less.
- Stage I Allowable Burn Days - Use of All Wood Burning Appliances Allowed - The forecasted average wind speed for the 6 PM to midnight period the following day is greater than 10 mph AND the forecasted average daily regional PM2.5 concentration for the next day is less than 25 ug/m3
- Accessing forecasted wind speeds from the National Weather Service can be automated via the internet and forecasting the next day’s PM2.5 levels, will be made by YSAQMD and the subsequent determination of whether the following day is an “Allowable Burn Day” and the appropriate stage can then quantitatively, and possibly automatically, determined. This information will be transmitted to designated City Staff and posted on the City’s website, voice mail system, and/or citizen and media email distribution lists as determined by Staff.

## 2. Exceptions

- Exceptions to the general restrictions on wood burning are proposed to allow wood burning for heat during power outages; in hardship cases where wood burning is the sole source of heat for the entire dwelling unit; and in appliances designed and exclusively used for cooking. This ordinance will not apply to any appliances using only gaseous fuel. Any open hearth fireplace which has been appropriately converted (under building permit) to use gaseous fuel qualifies for this exception. Any residential dwelling equipped with a working, non wood-burning appliance designed to provide space heating does not qualify for an exception. Such space heating appliances include, but are not limited to, a natural gas, propane-fired, or hot water driven central furnace or space heater, electrically-powered heat pump or electric resistance space heater, central furnace, portable, wall-mounted, or window-mounted unit.

## 3. Enforcement

- Enforcement of these provisions would be on a complaint basis, with the City Police Department being the responders. It would be treated by the police as any other nuisance complaint thus response by the Police Department will only be on an “as available” basis. We recommend that the ordinance only be enforced with “warnings” during the 2010-2011 burn season to allow residents time to become knowledgeable with the provisions of the ordinance through a Staff directed outreach program.

## 4. Permitting (Optional Consideration)

- The Council suggested previously that the NRC not include permitting in the final proposal to be submitted to Council. The Commission feels that the requirement of a permit would be extremely useful for both educational and law enforcement purposes (see below). We have thus included it as an optional component of this draft ordinance to begin only in the 2<sup>nd</sup> wood burning season after implementation of the ordinance. The permit would indicate whether the wood burning appliance was EPA-certified, super-efficient, or uncertified, because these different appliance types are allowed to be used on different burn days. We recommend that the cost of any such permit be not greater than \$50 for any one wood-burning season which should be sufficient to administer the program without additional costs to the city.

a) Enforcement of the wood burning ordinance would be greatly simplified for law enforcement officials if a permit system is used. Upon receipt of a complaint from a neighbor, the police department staff can simply check the City’s website to determine the Allowable Burn status and then review its records to see what level of permit, if any, is on file for the residence which is indicated to be burning wood. If this records search is inconclusive or if an exact address of the home burning wood is not known, then the police officer can be dispatched in the field and use a simple infrared viewer focused on a chimney to identify if a

wood-burning appliance is in use at the suspected residence – much like a decibel meter is now used to determine if public noise is excessive. By doing so, the police officer could then instantly determine if the wood-burning activity is lawful without ever even leaving their patrol vehicles requiring even less effort to enforce than a noise complaint which requires an officer to leave their car to get a property line noise level reading. This could result in substantial time savings to law enforcement officials.

b) A wood burning permit would be issued upon the condition that the permit holder acknowledge that they have read and understood educational materials made available by the city (as provided by the YSAQMD) and that they agree to commence wood burning only on “Allowable Burn Days” consistent with the type of wood burning appliance they employ. Educational materials are essential because wood burned improperly may heat up poorly, creating excess particulate matter and emitting the potent greenhouse gas methane. In addition, some woods burn more cleanly than others.

#### Predicted Number of “Allowable Burn Days” Expected under the Proposed Control

Strategy - The following graph shows each day during the 2007-2008 burn season as a single point based on the actual daily average PM2.5 concentration and the actual evening hours wind speed. If these actual average values represented the forecasted average PM2.5 concentrations and wind speeds made the previous day, the following number of days would have resulted in which use of various wood burning appliances was allowed or disallowed

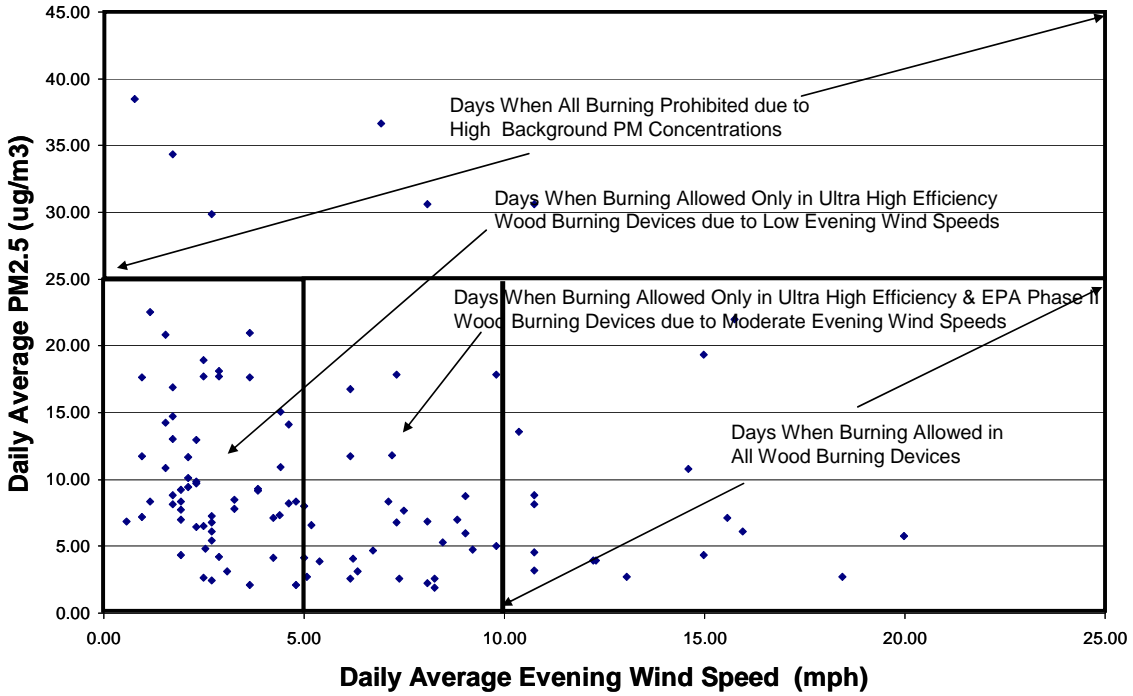
No Wood Burning Allowed – 6 Days of the 120 Day Wood Burning Season

Stage III Allowable Burn Days (Only High Efficiency wood burning appliances would be allowed) - 114 of the 120 day wood burning season (95% of the time)

Stage II Allowable Burn Days (Only EPA Phase II-Approved and High Efficiency wood burning appliances would be allowed) - 64 of the 120 day wood burning season (55% of the time)

Stage I Allowable Burn Days (All wood burning appliances would be allowed) - 16 of the 120 day wood burning season (14% of the time)

**Daily Average Evening Wind Speed vs. Daily Average PM2.5**  
**11/1/2007 - 2/29/2008**



This assumes the actual PM and wind speed values during 2007-2008 are representative of an average wood-burning season in Davis and that the daily PM2.5 and wind speed forecasts highly correlate with actual PM2.5 concentrations and actual wind speed values.

## **APPENDIX A - Proposed Wood-Burning Ordinance**

### **CHAPTER (\_\_\_)**

#### **WOOD BURNING**

##### **Section 1: Purpose**

This ordinance establishes regulations on the use of Wood Burning Appliances in the City of Davis.

The City of Davis recognizes that while fireplaces and wood burning appliances are a desirable amenity, wood smoke consists of fine particles, which are regarded as a health hazard by both national and state health professionals. Air Quality Standards have been created identifying appropriately healthy maximum standards of particulates in the air. Further, use of wood burning appliances under certain local conditions may result in wood smoke concentrations that may significantly exceed particulate air quality standards and adversely affect nearby residents. The operation of wood burning appliances therefore needs to be controlled so as not to cause significant health risks to residents who live near them. This ordinance defines the meteorological and operational circumstances under which use of different types of wood-burning appliances are likely to create a local health hazard and prohibits the use of such different types of wood-burning appliances under such circumstances,

##### **Section 2: DEFINITIONS**

**COOKSTOVE:** Any wood fired appliance primarily for cooking food as described in Code of Federal Regulations 60.531.

**FIREPLACE:** Any permanently installed masonry or factory built appliance or device designed to burn wood and/or solid fuels to provide space heating and/or ambiance in a residential or commercial building.

**HIGH EFFICIENCY WOOD BURNING APPLIANCE:** Any wood burning appliance that operates with PM2.5 emissions of less than 2.0 grams/hour when tested in accordance with U.S. EPA requirements set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations or a Pellet-Fueled Wood Burning Heater.

**PELLET-FUELED WOOD BURNING HEATER:** Any wood burning heater which operates on pellet-fuel and is either U.S. EPA-certified or is exempted under U.S. EPA requirements set forth in Part 60, Title 40, Subpart AAA Code of Federal Regulations.

**U.S. EPA:** The United States Environmental Protection Agency.

**U.S. EPA PHASE -II CERTIFIED APPLIANCE:** Any appliance certified by the U.S. EPA that the unit meets the performance standards set forth in Part 60, Title 40 Subpart AAA Code of Federal Regulations.

**WOOD BURNING APPLIANCE:** Any fireplace, wood burning heater, or pellet-fired wood heater, or any similar enclosed appliance or device burning any solid fuel used for aesthetic or space-heating purposes.

**WOOD BURNING HEATER:** An enclosed, Wood Burning Appliance capable of and intended for space heating (i.e. a wood stove or fireplace insert)

**WOOD FIRED OVEN:** Any permanently installed masonry or factory built cookstove designed to cook foods in an enclosed portion of the appliance.

**BARBEQUE GRILL:** Any permanently installed masonry or factory built cookstove designed to cook foods above burning wood or coals derived from burning wood.

### **SEC. 3. APPLICABILITY**

All Wood Burning Appliances installed in buildings.

### **SEC. 4. EXEMPTIONS**

This chapter does not apply to the following:

1. Any period when a Wood Burning Appliance is a residential dwelling unit's temporary and sole source of heat, providing that such temporary occurrence does not extend for more than a period of time reasonably required to repair or replace any non-wood burning equipment or appliances whose malfunction resulted in loss of space heating availability in the residential unit.
2. Any appliance exclusively fired with a gaseous fuel, or
3. Any Wood Burning Appliance specifically designed for and exclusively used for cooking such as a cook stove, wood-fired oven, or barbeque grill.
4. Any period when an emergency has been declared and/or during which electrical power service or natural gas delivery service is not available from the local utility provider.

### **SEC. 5. GENERAL REQUIREMENTS**

Effective November 1, 2010, it shall be unlawful to operate any type of Wood Burning Appliance to burn wood or wood products with a moisture content exceeding 20% ("unseasoned wood"). It shall be unlawful to continue operating a wood burning appliance if visible smoke is produced more than 30 minutes after the fire in the wood burning appliance was started).

In addition, operation of wood burning appliances will only be lawful on days which the City has posted to be "Allowable Burn Days" for each of three categories of appliances. The City shall determine Allowable Burn Days according to air quality and wind forecasts made the day before the Allowable Burn Day, as follows:

1. Allowable Burn Days only occur on days for which Yolo Solano Air Quality Management District has forecast an average daily regional PM2.5 concentration 25 ug/m3 or less.
2. During a Stage I Allowable Burn Day any wood burning appliance may operate. Stage I Allowable Burn Days shall occur when the PM2.5 standard is met and the National Weather Service has forecast an average hourly wind speed of at least 10 mph,
3. During a Stage II Allowable Burn Day, only High Efficiency Wood Burning Appliances or EPA Phase II-Certified Appliances may operate. Stage II Allowable Burn Days shall occur when the PM2.5 standard is met and the National Weather Service has forecast an average hourly wind speed of at least 5 mph but less than 10 mph.,
4. During a Stage III Allowable Burn Day, only High Efficiency Wood Burning Appliances may operate. Stage III Allowable Burn Days shall occur when the PM2.5 standard is met and the National Weather Service has forecast an average hourly wind speed of less than 5 mph.,

The determination and posting of Allowable Burn Days stages will be made by 12:00 noon on the day prior to the day determined to be an Allowable Burn Day;

Effective November 1, 2011, it shall be unlawful to operate any Wood Burning Appliance or fireplace for which a wood-burning permit issued by the city has not been obtained;

## **SEC. 6. ENFORCEMENT**

a) Any person convicted of violating or of permitting violation of any of the provisions of this chapter shall be punished by a fine. The schedule of fines shall be determined and announced by City Staff each year, and shall be at least 10% of and not more than 100% of the fine levels allowed under section 36900 (b) of the California Government Code, or successor legislation.

b) Any person receiving written or verbal notice from law enforcement or City staff that they are in violation of any provision of this chapter must correct the violation as soon as they are reasonably capable of doing so or of having someone do so for them. Failing to correct the violation as soon as is reasonably possible constitutes a separate offense punishable by an additional fine. Each repetition of the violation constitutes a separate violation punishable by an additional fine. The Courts may reduce fines in hardship cases.

c) Upon the third confirmed violation of this chapter within a twenty four-hour period of time beginning on the first notice of violation issued, the police department may take action as necessary to abate the wood-burning violation, including but not limited to instructing the wood-burning appliance user to "extinguish the fire" or physically arresting the wood-burning appliance user.

## **Appendix B**

### **Technical Justification of the Proposed Ordinance**

#### **Synopsis**

Numerous jurisdictions restrict wood burning when ambient PM<sub>2.5</sub> concentrations exceed federal thresholds, but this does not address the nearest-neighbor impacts of wood-burning. Citizens near wood burning homes can be exposed to smoke levels well above federal standards while regional air quality remains acceptable. Sensitive receptors like asthmatics are particularly harmed by near neighbor emissions. Since wind can disperse the particulate matter in local hotspots, the NRC proposes an ordinance based on modeling-supported wind speeds and cognizant of the emissions levels of different types of wood burning appliances. This appendix concludes with letters from health experts corroborating the adverse health effects of wood smoke and attesting to the appropriateness of the wind-speed based model proposed.

#### **Introduction**

In recognition of the growing body of evidence about the adverse health effects of particulate matter in wood smoke, the US Environmental Protection Agency has recently lowered its 24-hour PM<sub>2.5</sub> exposure standard from 65 to 35 micrograms/cubic meter (ug/m<sup>3</sup>). In order to reduce ambient winter time PM pollution and achieve regional compliance with this new standard, every regional air pollution control regulatory body in California that encompasses substantial urban areas have enacted various mandates and restrictions governing wood-burning within the last several years.

In addition to various requirements to have cleaner-burning EPA Phase II-Certified Stoves installed in new construction or on retrofit of wood-burning appliances and restricting sale or use of wet wood, these regulatory efforts have primarily focused on mandatory restrictions on wood-burning when the regional ambient PM<sub>2.5</sub> concentrations exceed or are predicted to exceed the federal threshold. These restrictions result in varying number of days of wood burning prohibition depending on the degree of PM pollution in the region. In Fresno which has high background levels of PM pollution, it is estimated that newly imposed restrictions will result in 45 “No-Burn Days” in an average 120-day burn season. In Sacramento which has less PM air pollution, it is estimated it will result in from 10-15 days in a burn season in which wood-burning would be prohibited.

Until recently, however, no research has been performed that looks at the concentrations of PM pollution that can actually occur down at the neighborhood level (vs. regional PM concentrations) as a result of local residential wood-burning occurring upwind from exposed citizens. Because wood smoke is produced by single point source emitters and is variably dispersed and diluted downwind, ground-level PM concentrations can be produced that are substantially higher than average regional pollution levels under certain atmospheric conditions. This could lead to exposure by citizens to excessive PM pollution in the air of these neighborhood “hotspots” even though regional particulate matter concentrations may be much lower. Conversely, there are times in which local atmospheric conditions are such that smaller amounts of ground-level pollution will occur from wood burning (such as with high winds and



unstable atmospheric conditions), but that regional PM concentrations are such that no additional burning should occur due to the risk of downwind exposures in excess of the Federal standards.

Recognizing these dual aspects of wood smoke pollution control, the NRC has considered two different methodologies to determine when a day is an “Allowable Burn Day”.

1) The Yolo Solano Air Quality Management District has an existing methodology in which PM concentrations are routinely forecasted for the following day during winter months. Under this program, when the regional average PM<sub>2.5</sub> concentration is projected to exceed 25 ug/m<sup>3</sup> on the following day, a “Don’t Light Tonight” alert is announced in which voluntary curtailment of wood burning is encouraged. This program can be easily modified to meet the specific needs of a mandatory wood-burning restriction program in Davis as further discussed below.

2) A wind based-methodology based on EPA-approved software modeling tools has been considered based on research performed by Yolo Clean Air and a researcher at Lawrence Berkeley Laboratories on behalf of the City of Berkeley. This modeling tool has shown that excessive levels of ground-level wood smoke pollution can occur and persist during night time burning hours when wind speeds are less than 5 mph even when the wood burning appliance is an EPA Phase II-Certified wood stove or insert.

The NRC finds that the of both methodologies have technical merit in the manner in which they address the problem and recommends that BOTH be included in the final determination of whether or not a following day is an “Allowable Burn Day” as more fully described below.

### **Calculation of the Daily Net Exposure of an Individual to Wood Smoke PM Pollution**

The underlying intent of the NRC’s effort is to prevent citizens from being exposed to excessive levels of wood smoke pollution. The calculation of the cumulative exposure of an individual to particulate pollution over a day in which there is no additional local wood-burning contributing to regional pollution levels is very simple.

One simply multiplies the average regional background PM<sub>2.5</sub> concentration in ug/m<sup>3</sup> and multiplies it times 24 hours (e.g. an average concentration of 20 ug/m<sup>3</sup> times 24 hours = 480 ug/m<sup>3</sup>-hours) to yield the cumulative exposure during that 24-hour period. This exposure value so calculated can then be directly compared to the exposure allowed under the existing Federal 24-Hour PM<sub>2.5</sub> Standard (i.e. 35 ug/m<sup>3</sup> x 24 hours = 840 ug/m<sup>3</sup>-hours) to determine the degree of the exposure to which the citizen was subjected compared to the Federal standard. In the above case where the cumulative exposure over the day equaled 480 ug/m<sup>3</sup>-hours, it equated to about 57% of the exposure allowed under the Federal standards (480 ug/m<sup>3</sup>-hours / 840 ug/m<sup>3</sup>-hours).

However, it is important to note that the Federal exposure standards promulgated by the US EPA are specifically designed to NOT protect ALL people from all ill-effects of harmful substances. Implicit in the statistical analysis performed when determining the

actual levels at which standards are set is the explicit understanding that there is a segment of the population that is simply more sensitive to the pollutant in question than the general population and that the threshold levels established by the Federal standards will almost certainly be harmful to this susceptible population. In the case of wood smoke pollution, the susceptible population is primarily seniors and children with impaired respiratory and/or heart problems. Particularly with respect to children, the NRC understands that the problem of respiratory health is very rapidly becoming a chronic problem in the Valley and that regional PM levels are sometimes harmful to children even if below Federal thresholds. Thus, one intent of the NRC is to establish standards that also protect this innocent and protectionless subset of the general population

Further, there was substantial controversy surrounding the decision to set the new standard at the 35 ug/m<sup>3</sup> level. This is because the consensus recommendation for the standard made by the EPA's advisory committee after studying the epidemiology and health effects of PM<sub>2.5</sub> exposure was for a PM<sub>2.5</sub> standard in the range of 25 to 35 ug/m<sup>3</sup>. The decision to use the higher value was subsequently arbitrarily made by the EPA administrator and Bush administration. Thus, in consideration of the intent of the NRC to protect, where possible, those in our community with respiratory impairments, we recommend and have used the conservative lower range value of 25 ug/m<sup>3</sup> to establish the maximum exposure to which a citizen should be exposed. Therefore, a "recommended" maximum net 24-hour PM 2.5 exposure was calculated by multiplying 25 ug/m<sup>3</sup> times 24 hours = 600 ug/m<sup>3</sup>-hours instead of the maximum exposure allowed under the Federal Standard of 840 ug/m<sup>3</sup>-hours. The 25 ug/m<sup>3</sup> threshold is the current maximum predicted PM<sub>2.5</sub> concentration above which voluntary curtailments of wood burning are requested by both the Yolo Solano and Sacramento Air Quality Management Districts.

Given this intent, we recommend that the threshold average daily forecasted PM<sub>2.5</sub> concentration limit used by the YSAQMD to determine "Allowable Burn Days" in Davis be established at 25 ug/m<sup>3</sup> instead of the current value of 35 ug/m<sup>3</sup> used in their voluntary "Don't Light Tonight" program.

To predict the levels of PM pollution and exposure that might occur due to wood-burning under mild to moderate wind speeds, EPA-approved software (Screen3) was employed to model particulate pollution dispersion from a chimney stack. The software quantitatively estimates the maximum 1-hour concentrations of PM pollution that would be expected to occur at ground-level downwind from a chimney under different meteorological conditions. Once these maximum predicted concentrations were determined, they were "factored" lower by the recommended 20% (for a 6-hour duration) to account for the fact that wind speeds and direction change over time. (Note: The "factor" for 6 hours was chosen because this is the maximum length of time expected that most fires would operate – e.g. from 6 PM until midnight). This "factoring" has the effect of reducing the average ground level PM concentration that would be expected to occur over a six-hour period given the same emission rate.

The resulting daily PM "exposure" to which a citizen downwind from a fireplace burning for 6 hours is potentially exposed (given the specified fireplace emission rate and atmospheric conditions and background PM) can then be calculated as follows:

Daily PM Exposure = (Maximum predicted 1-hour PM<sub>2.5</sub> concentration times the 6-hour “factor” plus the Background PM concentration) times 6 hours of exposure plus the Background PM concentration times 18 hours. This will yield a daily 24-hour net exposure in micrograms per cubic meter-hours (ug/m<sup>3</sup>-hrs) directly compared against the recommended maximum daily exposure threshold of 600 ug/m<sup>3</sup>-hours which is based on the recommended 24-hour PM<sub>2.5</sub> standard of 25 ug/m<sup>3</sup> as discussed above.

For example, assuming a fire from an EPA Phase II-Certified wood stove is predicted to produce a 1-hour maximum downwind, ground-level concentration of 90 ug/m<sup>3</sup> given certain atmospheric conditions. Also assume the fire is burning for 6 hours and the average background PM concentration is 12 ug/m<sup>3</sup> (as was actually calculated from a UC Davis monitoring station over the entire 06-07 burn season). The NRC understands that this background PM concentration may be low and thus may underestimate the net exposure to person exposed to wood smoke. That notwithstanding The net 24-hour PM<sub>2.5</sub> exposure of a citizen so exposed can thus be calculated as follows:

$$[(90 \text{ ug/m}^3 \times 80\% \text{ factored} + 12 \text{ ug/m}^3) \times 6 \text{ hours}] + [12 \text{ ug/m}^3 \times 18 \text{ hours}] = 720 \text{ ug/m}^3\text{-hrs.}$$

The recommended maximum 24-hour PM<sub>2.5</sub> exposure is 25 ug/m<sup>3</sup> x 24-hours = 600 ug/m<sup>3</sup>-hours.

Thus the predicted exposure of a citizen so exposed is approximately 120% of the recommended standard (predicted exposure of 720 ug/m<sup>3</sup>-hrs / recommended maximum exposure threshold of 600 ug/m<sup>3</sup>-hrs) and this would be considered an excessive exposure under which specified meteorological conditions wood-burning should be prohibited for even EPA Phase II-Approved appliances.

### **Using Dispersion Modeling Tools to Predicted Downwind Wood Smoke Concentrations under Different Meteorological Conditions**

Estimates of particulate pollution plumes dispersed from point sources under different wind speeds and atmospheric conditions and the resultant ground level concentrations were then made using EPA-approved dispersion software tool known as Screen 3. Screen 3 uses industry accepted algorithms known as the Industrial Source Complex (ISC3) dispersion model. ISC3 is a steady-state Gaussian air dispersion model which can be used to assess pollutant concentrations from a wide variety of sources. The basic algorithms are available for use in a number of software packages made available through the EPA or other governmental agencies as free downloads. Some commercial vendors also add an overlay and additional statistical or graphical capabilities to the source calculations to allow for increased ease of operation, production of additional information, or graphical representation. The ISC3 algorithms have been widely used to predict dispersion of pollutants for regulatory compliance in California for many years.

The particular software employing the ISC3 algorithms used in this study is called Screen3 which can be freely downloaded from the US EPA. Screen3 also employs the EPA-approved BPIP (Building Profile Input Program) algorithms that calculate the impact of building downwash on downwind concentrations of pollutants. Building

downwash is the creation of cavity zones by air moving around or over buildings and can have significant impacts on downwind concentrations of wood smoke pollution.

The Screen3 software was used to predict maximum steady-state downwind PM concentrations at ground level resulting from the use of either a conventional open hearth fireplace or an EPA Phase II-Certified wood stove. The particulate emissions from each of the wood-burning sources were assumed to be discharged from a 15 ft chimney above a single story home approximately 50 ft wide by 50 ft. long. The model was run using 4 different wind speeds (2.5 mph, 5.0 mph, 7.5 mph, and 10 mph) at the 6 different levels of atmospheric stability allowed by the program.

The general methodology employed in predicting these exposures has been presented to Dr. Anthony Wexler of the University of California at Davis. Dr. Wexler is a full professor in 3 departments at the University of California at Davis (Mechanical and Aeronautical Engineering, Civil and Environmental Engineering, Land, Air and Water Resources) and is additionally the Director of 3 different Research Institutes headquartered at UC Davis (Air Quality Research Center, Crocker Nuclear Laboratory, and San Joaquin Valley Aerosol Health Effects Research Center). His analysis is attached as an addendum to this Appendix

The meteorological parameters and other physical values selected for use in the generation of the models are believed to be representative of normal conditions existing in Davis during winter months. Detailed discussion of the selection of the ISC3 algorithms and all Screen 3 program inputs and assumptions used in the preparation of this report are available upon request.

### **Results of Wood Smoke Dispersion Modeling and Calculation of 24-Hour PM Exposures**

The maximum ground-level 1-hour concentrations predicted for each point source type (EPA Phase II-Certified stoves or Open Hearth fireplaces) and for each meteorological combination of wind speed and stability factor is shown in the following table. The resultant percentage of the recommended 24-hour PM<sub>2.5</sub> exposure threshold that results from exposure to this predicted concentration is also shown for each type of fireplace or wood stove and the different meteorological combinations.

**Predicted Maximum 1-Hour Concentrations of Wood Smoke Particulate Matter Dispersed from a Single Fireplace under Different Atmospheric Conditions and the Predicted Percentage of the "Recommended" 24-Hour PM2.5 Threshold that would Result if Burning Occurred 6 Hours per Day**

Run No.	Wind speed		Insolation Conditions	Pasquill Stability Factor (K)	EPA Phase II Certified	Open Hearth	EPA Phase II Certified	Open Hearth
	meter/s	mph			"- EPA"	\$	"- EPA"	"-Open"
Background PM	12	ug/m3		Run No.	"- EPA"	\$	"- EPA"	"-Open"
6-Hour Factor =	0.8			Emission Rate (g/s)	0.00228	0.01639	0.00228	0.01639
				Flue Diameter (m)	0.15	0.3	0.15	0.3
				Exhaust Velocity (m/s)	1	4	1	4
				Exhaust Temperature (K)	530	390	530	390

Run No.	meter/s	mph	Insolation Conditions	Pasquill Stability Factor (K)	Maximum Predicted PM Concentration (ug/m3) @ 2 m Height w No Background PM	Predicted % of "Recommended" 24-Hour PM2.5 Exposure Threshold if Operated for 6 Hours		
2.5-6	1.116	2.5	Night w Overcast	6	97.5	44.7	126%	84%
2.5-5	1.116	2.5	Night wo Overcast - Day w Heavy Overcast	5	64.7	29.5	100%	72%
2.5-4	1.116	2.5	Day w Moderate Overcast - Weak Insolation	4	51.5	35.4	89%	76%
2.5-3	1.116	2.5	Day w Slight Overcast - Slight Insolation	3	33.8	32.7	75%	74%
2.5-2	1.116	2.5	Day w Partial Clouds - Moderate Insolation	2	21.3	29.5	65%	72%
2.5-1	1.116	2.5	Day w No Clouds - Strong Insolation	1	14.8	30.1	60%	72%
5-6	2.232	5	Night w Overcast	6	53.2	285.3	91%	276%
5-5	2.232	5	Night wo Overcast - Day w Heavy Overcast	5	35.3	189.4	76%	200%
5-4	2.232	5	Day w Moderate Overcast - Weak Insolation	4	26.5	141.2	69%	161%
5-3	2.232	5	Day w Slight Overcast - Slight Insolation	3	17.4	92.5	62%	122%
5-2	2.232	5	Day w Partial Clouds - Moderate Insolation	2	10.5	58.3	56%	95%
5-1	2.232	5	Day w No Clouds - Strong Insolation	1	7.6	40.6	54%	80%
7.5-6	3.348	7.5	Night w Overcast	6	35.9	230	77%	232%
7.5-5	3.348	7.5	Night wo Overcast - Day w Heavy Overcast	5	23.8	152.7	67%	170%
7.5-4	3.348	7.5	Day w Moderate Overcast - Weak Insolation	4	17.8	113.8	62%	139%
7.5-3	3.348	7.5	Day w Slight Overcast - Slight Insolation	3	11.7	74.6	57%	108%
7.5-2	3.348	7.5	Day w Partial Clouds - Moderate Insolation	2	7.3	47	54%	86%
7.5-1	3.348	7.5	Day w No Clouds - Strong Insolation	1	NA	NA	NA	NA
10-6	4.464	10	Night w Overcast	6	NA	NA	NA	NA
10-5	4.464	10	Night wo Overcast - Day w Heavy Overcast	5	17.92	120.5	62%	144%
10-4	4.464	10	Day w Moderate Overcast - Weak Insolation	4	13.88	89.9	59%	120%
10-3	4.464	10	Day w Slight Overcast - Slight Insolation	3	8.765	58.9	55%	95%
10-2	4.464	10	Day w Partial Clouds - Moderate Insolation	2	5.5	37.1	52%	78%
10-1	4.464	10	Day w No Clouds - Strong Insolation	1	NA	NA	NA	NA

NA = Screen 3 does not allow this combination of Wind speed and Stability Factor

Recommended Maximum 24-Hour Federal PM2.5 Exposure = 25 ug/m3 \* 24 Hours = 600 ug/m3-hours

Predicted % of "Recommended" 24-Hour PM2.5 Threshold if Fireplace Operated 6 Hours = [(Predicted Maximum 1-Hour PM Concentration x 6 hr "factor" + Background PM) \* 6 Hours of Operation] + (Background PM x 18 Hours) / 600 ug/m3-hours (Note: Includes effects of background PM and the predicted 6-hour PM2.5 concentration "factor")

  - Indicates the predicted exposure is greater than the "recommended" 24-Hour PM2.5 exposure threshold

For instance, inspection of the far right-hand column of the above table shows that an open hearth fireplace operated for 6 hours during the night with overcast skies (atmospheric stability class 6) and a wind speed of 5.0 mph would result in approximate maximum downwind PM exposure equal to 276% of the recommended maximum 24-hour PM exposure threshold.

This information indicates that excessive exposures can occur at above 5 mph with EPA Phase II-Certified wood stoves. At 5 mph to 10 mph, an open hearth fireplace produces very high concentrations of PM2.5 that will produce exposures *far in excess* of the recommended 24-hour PM2.5 threshold. Above 10 mph, an open hearth fireplace produces concentrations of PM2.5 that will produce exposures *only marginally in excess* of the recommended 24-hour PM2.5 threshold

In addition to wind speed, one variable that has a significant impact on the predicted ground level maximum 1-hour PM<sub>2.5</sub> concentration is the degree of atmospheric stability. Atmospheric stability is primarily influenced by the degree of solar insolation that strikes the earth which itself is primarily affected by the time of day and the degree of cloud cover. Since the vast majority of wood burning occurs during the evening/night hours without sunlight, the modeling is simplified because during night hours one only has to look at two atmospheric stability classes – with and without cloud cover. Inspection of the table reveals that there is not an enormous degree of difference between the predicted maximum concentrations produced at night with and without cloud cover thus we have not included atmospheric stability as a recommended parameter to be used each day when forecasting whether the following day should be an “Allowable Burn Day”. A more refined model might be developed that included the forecasted degree of cloud cover predicted to occur the following evening and, in rare instances, it may affect whether or not an “Allowable Burn Day” might or might not be determined.

However, the practical complexities in determining “Allowable Burn Days” introduced using atmospheric stability and the degree of difficulty in explaining the basis for its use to the general public leads us to strongly recommend that the use of forecasted atmospheric stability not be used in the determination of “Allowable Burn Days” in this proposed ordinance.

One surprising aspect of this modeling work was that the predicted maximum concentrations of PM were less with an Open Hearth fireplace at a 2.5 mph wind speed than either the same Open Hearth Fireplace at higher wind speeds or an EPA Phase II-Approved wood stove at the same wind speed. This anomaly is much more pronounced at the more stable atmospheric conditions (i.e. higher Stability Constants) and despite the fact that the PM mass emissions rate of an Open Hearth fireplace is about 7 times greater over time than those from an EPA Phase II-Approved wood stove!

This apparent inconsistency is due to the uplifting dispersion effects of the high exhaust velocity of the Open Hearth fireplace relative to the lower wind speeds seen in this particular combination of meteorological conditions. As the exhaust velocity to wind speed ratio drops by either using an EPA Phase II approved wood stove with reduced exhaust velocity or with increasing wind speeds, the resulting wood smoke plume is forced downward so much higher PM<sub>2.5</sub> concentrations are predicted with Open Hearth Fireplaces at either higher wind speeds or stagnant air conditions. Thus, it is not practical to suggest a small wind speed “window” to allow burning with open hearth fireplaces because that window is very small from a meteorological point of view - i.e. variable wind speeds would enter and out of the “safe” wind speed window very quickly. This prevents effective practical enforcement of prohibited burning. Further, the degree of neighborhood pollution that otherwise results from burning in an open hearth fireplace when outside the “safe” wind speed “window” is so great that much would be risked to gain little if this wind speed window exemption was implemented for open hearth fireplaces. Thus, we strongly recommend against implementing a two-tiered approach to determination of “Allowable Burn Days” allowing for use of open hearth fire places during this very narrow wind speed “window”

Finally, it is important to note that this predicted net daily PM<sub>2.5</sub> exposure calculations assumes only one upwind fireplace and ambient background PM of only 12 ug/m<sup>3</sup>. If the background PM concentration is higher than 12 ug/m<sup>3</sup> as often occurs, then this degree of exposure relative to the recommended exposure threshold increases. If one or more additional fireplaces are also being used in close upwind proximity, this will also contribute additional PM to the converged plumes and the degree of exposure to the exposed individual also increases.

### **Other Modeling Studies Also Demonstrate that Local Excessive Concentrations of Wood Smoke Pollution can Occur**

Another study which similarly investigated the localized effects of wood smoke pollution was performed by Dr. Robert Clear of Lawrence Berkeley Laboratories for the City of Berkeley. That study also used Screen3 software to predict maximum 1-hour downwind concentrations of wood smoke from different types of fireplaces under an extensive number different physical, topographical, and atmospheric conditions. As in our own modeling work, Dr. Clear shows in his study that there is a clear potential for excessive PM exposure to some residents to wood smoke pollution during evenings with low wind speed conditions even if the pollution source is a comparatively "low emission" EPA Phase II-Certified wood stove. Dr. Clear draws the following conclusions from his extensive study:

*“The first and most important point to make based on the runs shown here is that they confirm our original concern that wood smoke from a chimney is capable of producing a local problem while background levels remain below the level of regulatory concern. The rapid decline of concentration with distance demonstrates that treating wood smoke as a purely regional problem can lead to significant underestimation of its health effects, with a fraction of the population that is adjacent to a wood burning appliance being exposed to particulate levels that can be far in excess of regulatory limits.*

*A second important point is that it does not appear that making “spare the air nights” mandatory will prevent local problems. Wood smoke can be a problem even under unstable atmospheric conditions if wind speeds are low and can still be a problem under neutral conditions at moderate wind speeds. Bans on wood burning due to meteorological conditions would have to be extended to even fairly moderate conditions to prevent air quality problems. In fact, even this would not be sufficient. The figures show that under some conditions air quality standards can be violated in as little as fifteen minutes.”*

The full study is available upon request



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October 25, 2008

Alan Pryor  
Yolo Clean Air  
2736 Brentwood Pl.  
Davis, CA 95618

Alan,

I have reviewed "Appendix B – Technical Justification" of the draft document entitled "NRC WoodBurning Ordinance Recommendation\_Draft\_10-21-08.pdf"

Wood smoke is known to be a serious source of PM air pollution in this area and many others. We are particularly susceptible in the Valley during winter because cold temperatures and high humidities often occur when we have relatively stagnant air conditions with strong inversions close to the surface trapping air pollutants close to where we breathe.

Generally, the closer you are to a pollution source, the higher the concentration that you are exposed to. This is not always the case, such as when you are very close to a tall stack, but otherwise it is true. Of course, if the wind blows the air pollutants from the stack towards you, then you are going to breathe it, whereas if it blows away from you, then you won't be as exposed. Air currents are not steady due to turbulence in the atmosphere so the plume from an emission may disperse. That is what your calculations illustrate.

These types of dispersion models are widely used for predicting the dispersion patterns and ground level concentrations of pollutants; most often from industrial stacks. When they are otherwise used to predict dispersion from fireplace chimneys in residential neighborhoods, they must also take into account local building heights. This is because the buildings themselves can cause turbulence dispersing and diluting the pollutant more or they may trap pollutants causing even higher concentrations than such models will predict. I understand from you that the EPA-approved Screen3 software you employed in your modeling work incorporated these standard building downdraft calculations. I otherwise have not reviewed all the input parameters you used, and they do matter, but your approach is generally sound for understanding the pattern of dispersion and approximately what is going on.

Your use of these forecasted ground level concentrations to then estimate the potential for excessive time-weighted exposure to wood smoke pollution is also an appropriate methodology for approximately predicting the atmospheric concentrations under which different types of different fireplaces can be safely used.



I was intrigued by your comparison of open hearth fireplaces versus wood stoves, and the conclusion that open hearth fireplaces often lead to lower pollutant exposure. In this era of increasing awareness of climate change, it is worth noting that open hearth fireplaces are beautiful but do not provide much heat to the home. In fact, they generally draw more air out of the home than they heat which may lead residents to using their furnace while using their fireplace, possibly burning more natural gas and emitting more greenhouse gases.

In summary, I think the general conclusions you reached that potentially excessive exposures to neighborhood wood smoke can result from local wood burning under low wind conditions are valid. Further, I believe that your recommendation to prohibit wood burning under those potentially unsafe atmospheric conditions is reasonable and should definitely reduce the potential for excessive exposure to residents downwind from burning fireplaces under these conditions.

I do note that your modeling work assumes that pollution from only a single wood-burning fireplace is produced and dispersed in a neighborhood. To the extent that more than one fireplace is operating upwind from a home, excessive exposures to wood smoke pollution could still occur even under the atmospheric conditions you otherwise believe are considered safe if the separate pollution plumes converge.

Thank you for performing this study and looking out for the health of residents of our community.

Sincerely,

Anthony Wexler  
Professor  
Mechanical and Aeronautical Engineering  
Civil and Environmental Engineering  
Land, Air and Water Resources  
Director  
Air Quality Research Center  
San Joaquin Valley Aerosol Health Effects Research  
Center

## Appendix C

### Other Letters of Support for Wood Burning Restrictions from Physicians and Health Organizations

February 21, 2008

Bruce Kemp, Chair  
Jennifer Holman, Vice Chair  
Members, Natural Resources Commission  
City of Davis  
23 Russell Blvd  
Davis, CA 95616

Re. Regulating Wood Smoke Pollution

Dear Chairman Kemp and Members of the Natural Resources Commission,

Thank you very much for the opportunity to comment on efforts to restrict wood smoke pollution in the City of Davis. Due to health impacts caused by breathing wood smoke pollution, we applaud your interest in reducing wood smoke pollution in Davis to the maximum extent possible.

The science on health impacts of wood smoke pollution has advanced considerably over the last two decades. Wood smoke is comprised of tiny particles which have been associated with adverse health outcomes, including increased mortality. Breathing wood smoke can aggravate a host of illnesses, ranging from asthma and emphysema to heart disease. Last September, after a review of the thousands of studies examining health effects of particle pollution, the United States Environmental Protection Agency set a 24-hour threshold for particle pollution at 35 micrograms per cubic meter, cutting by half the allowable particles in the air.

Every winter, the American Lung Association of California receives phone calls from distraught residents suffering from health problems caused by wood burning from their neighbor's chimney's. Often, they have young children with asthma who are literally unable to breathe in their own homes. Some of these families have had to resort to selling their homes and moving to areas with less wood smoke pollution. The American Lung Association of California has worked closely with air districts throughout the region to educate the public on the harmful effects of wood smoke and to encourage the adoption of measures to reduce exposures. Despite many local air pollution control efforts, the lack of controls on wood smoke pollution in neighborhoods continues to create unhealthy air for many.

Thank you for your leadership in protecting the health of your community and promoting clean, healthy air. Cleaner burning alternatives are available to enjoy the glow without the smoke. Please don't hesitate to contact us if you have any questions, or if we can provide you with any assistance.

Sincerely,

Barbara Beedon  
Regional Vice President

## **Letter to City of Davis City Council**

### **BREATHING SOOT IS DANGEROUS TO YOUR HEALTH**

**By Anthony Gerber, MD, PhD**

The City of Davis has a critical opportunity to improve public health with the proposed wood burning regulation that will help eliminate the harmful effects of breathing wood smoke pollution. The ordinance addresses a common situation in many communities where individuals are exposed to their neighbors' wood burning pollution. The American Lung Association of California and the California Thoracic Society applauds the City of Davis for proposing a strong wood burning ordinance and following in the footsteps of so many other communities that have already taken this important step to protect the public's health.

Wood smoke comprises the largest single source of particle pollution in the wintertime. When inhaled, these tiny particles can lodge deep into the lungs. Breathing even low levels of this pollution increases the risk of premature death. Research has also linked particle pollution to lung cancer, heart attacks, asthma attacks, strokes as well as increased admissions to the hospital for respiratory and heart conditions.

Given the known harmful effects of exposure to wood smoke pollution, the regulations proposed by the City of Davis are long overdue. Despite regional air pollution control efforts, the lack of controls on wood burning and wood smoke pollution has created unhealthy air for everyone in Davis and a situation where neighbors are suffering health effects, becoming prisoners to their neighbors' wood burning pollution.

It may seem hard to believe that something so "natural" as wood could actually be harmful to our health. But forty years ago, we thought smoking was harmless, as well. Today, if an industry emitted as much particulate pollution as some chimneys do, it would be required to have a permit or be shut down.

In the Bay Area, nearly 1 million people have asthma, including 200,000 children. An additional 300,000 have been diagnosed with emphysema, lung cancer and chronic bronchitis. The pervasive problem of respiratory disease is even greater in the Central Valley. Lung disease is the fastest growing cause of death in the United States.

Local and regional government agencies must take leadership on controlling soot pollution from wood smoke.

Data shows that there is public support for wood burning, but there is no public support for wood smoke pollution. Cleaner burning alternatives are available to enjoy the glow without the smoke, such as natural gas stoves, pellet stoves, and electric devices.

Why a regulation? For years, regional voluntary and neighbor-to-neighbor measures have been tried. Once educated about the health effects, many people have turned to cleaner burning alternatives. Most residents are good neighbors and will comply and find ways to stay warm without causing harm to their neighbors. But for those who continue to pollute the air with toxic wood smoke, regulations are needed. Everyone thought restricting smoking in public

places would cause huge problems. It has not. People have adjusted because they know it is a matter of public health. Other air districts such as the San Joaquin Valley, the Sacramento Air Quality Management District, and the Bay Area Air Quality Management District have mandatory restrictions on wood burning when atmospheric conditions favor smoke buildup and local residents have taken it in stride, because they understand it is a critical public health issue.

Some day we will look back on wood smoke pollution as we did smoking. Both are hazardous to our health and should be restricted.

*Anthony Gerber, MD, PhD, is Assistant Professor of Medicine at the University of California, San Francisco, specializing in pulmonology and critical care medicine.*

To: Davis City Council:

January 1, 2009

From: Bonnie Gieschen, MD

I am writing in support of a marked restriction on, or better yet, complete elimination of the use of wood burning fireplaces. There is more and more information becoming available that their use contributes significantly to the poor air quality in the Sacramento region, especially in the winter months.

I will let the air quality scientists quote particulate size and relative contributions made to air pollution by other sources. The information I have read underscores the danger posed by the fine particles produced and the multiple carcinogens released into the atmosphere by the wood burning. Both of these factors contribute to the health risks faced by all of us as a result of the decrease in air quality. This is especially true of the vulnerable populations I care for, both young children, and the elderly, especially those with preexisting lung disease. It is well known that childhood asthma has been increasing dramatically in the past several years, and air pollution has been one of the factors blamed for this rise. I have also seen for myself numerous cases of environmental factors triggering a flare of Chronic Obstructive Lung Disease or Asthma in my patients. We would have a dramatic increase in “lung cases” in the days (not that long ago) when the rice fields were regularly burned. I have had specific patients who have presented with a flare of their lung disease from indoor wood burning stoves, and as more information becomes available the cumulative contribution of all the individual stoves or fireplaces is apparent.

Especially where wood burning stoves or fireplaces are used “for effect” there needs to be a ban with a transition to the much safer options of natural gas or propane if one desires this luxury. In the relatively few cases where wood burning is a necessity I would support funds to help those in need to transition to a safer (for all) technology.

Sincerely,

Bonnie Gieschen M.D.  
Internal Medicine/Pediatrics  
2701 Brentwood Pl  
Davis, CA 95618

January 5, 2009

Dear Mayor Asmundson and City Council Members:

I understand that you will soon be considering a residential wood smoke ordinance. I've been interested in residential wood smoke for many years, both because it has been repeatedly shown to be a major source of regional particulate matter (PM) concentrations in the winter and because the uneven distribution of smoke generated in neighborhoods can result in very high localized pollution. As a former chairman of the Public Health Committee of the Bay Area Air Quality Management District's Advisory Council, as well as Chairman of the Environmental and Occupational Health Committee of the erstwhile American Lung Association of the East Bay, I am quite familiar with the problems of wood smoke pollution, particularly in inland valleys. Even in areas with good regional air quality, neighbors of someone who burns wood on a regular basis may receive substantial exposures to fine PM as well as gaseous respiratory irritants in wood smoke. When I was still working primarily on air pollution issues, I used to receive phone calls from people throughout California who lived downwind of someone using a wood stove during the fall and winter, asking what recourse they had when their neighbor would not respond to reasonable requests to abate the smoke. Basically there was little that the individual could do other than to bring a private nuisance lawsuit, which would mean spending thousands of dollars to participate in a process with a very uncertain result. There were several instances in which relocation was the only "solution" to this localized air pollution problem.

On a related topic, while the published literature on wood smoke-related health effects is sparse, it is clear that such smoke can exacerbate pre-existing respiratory disease. For instance, in the Santa Clara area, wood stoves and fireplaces have historically been major contributors to winter PM pollution, which has been associated with a greater than 40% increase in the risk of emergency room visits for asthma, especially during episodes of low temperatures (Lipsett M et al. [Air pollution and emergency room visits for asthma in Santa Clara County, California](#). Environmental Health Perspectives, vol 105, pp. 216-222, 1997). Virtually all methodologically sound epidemiological studies of the health impacts of wildfire smoke on populations have clearly documented associations with respiratory illness, as described in a recent wood smoke review article, on which I was a co-author ([Wood smoke health effects: A review](#). Inhalation Toxicology, vol. 19, pp. 67-106, 2007). There have been few studies examining the circulatory effects of exposure to wood smoke, per se, and therefore it is premature to make any pronouncements about cardiovascular effects of smoke mixtures routinely encountered in suburban areas. However, there are both human and animal data linking wood smoke exposures to systemic inflammation, which is thought to be one of the risk factors for precipitating circulatory events. Also, to the extent that wood smoke contributes to combustion particle burdens in a given region, it is likely to contribute to health effects that have been linked with PM exposures.

I hope that these comments are helpful in your deliberations about how best to protect public health. Thank you for your consideration,

Michael Lipsett, M.D. , Chief - Exposure Assessment Section  
California Department of Health Services

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January 5, 2009

The Honorable Ruth Asmundson, Mayor  
The Honorable Don Saylor, Mayor Pro Tempore  
The Honorable Sue Greenwald, Councilmember  
The Honorable Lamar Heystek, Councilmember  
The Honorable Stephen Souza, Councilmember

Dear Mayor Asmundson and City Councilmembers,

Re: Proposed Wood burning Ban and Restriction Ordinance

Breathe California Sacramento Emigrant Trails Chapter has reviewed the proposed ordinance and convened a task force to hear comments from the ordinance proponent and consider input from air quality experts regarding existing programs, and scientific data that exist related to the topic. The following comments are offered for your consideration.

EPA ambient air quality standards for particulate matter have been established, based upon scientific research review and data evaluation and are considered sufficient to protect a cross section of the population with a built in margin of safety. Existing burn restriction programs currently implemented within the region by air quality districts focus on the attainment of the federal standard for the protection of public health. However it is understood that there will occur situations wherein high risk individuals with acute cardio-respiratory problems, comprising a small segment of the population, are subjected to smoke levels in "dense smoke pockets" of urban areas that will exacerbate health problems. Given this understanding the proposed ordinance focus on limiting burning only on allowable days based on lower readings and wind speeds has merit, as it will afford added protection to susceptible individuals.

We also support the continued efforts of the city to work with Dr. Cahill to acquire sound scientific data prior to consideration of any further restrictions, including the consideration of a ban on burning within the city.

We thank you for the opportunity to provide comments, and applaud the city's efforts to consider the health concerns of breathing compromised citizens of Davis.

Sincerely,

Norm Covell  
Volunteer Task Force Chair